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FARMERS' BULLETIN No. 1438

MAKING FERMENTED PICKLES



INFORMATION AND DIRECTIONS for pickling vegetables in brine have been prepared for the use of housewives and producers of pickles, and to meet the needs of extension workers.

Cucumber (salt, sour, sweet, dill, and mixed) pickles and sauerkraut are given most attention. String beans, green tomatoes, chayotes, mango melons, burr gherkins, cauliflower, corn on the cob, and some fruits, such as peaches and pears, are mentioned.

Although intended mainly for guidance in putting up pickles on a small scale in the home, this bulletin may be used also in preparing large quantities on a commercial or semicommercial scale.

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MAKING FERMENTED PICKLES

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ALTHOUGH excellent pickles can be bought on the market at all seasons of the year, many housewives prefer to make their own, particularly when their home gardens afford a plentiful supply of cucumbers.

Brining is a good way to save surplus cucumbers that can not be used or readily sold in the fresh state. Instead of letting them go to waste it is very easy to cure them, after which they may be held as long as desired or until they can be sold to advantage, either in local markets or to pickle manufacturers. Thus growers are protected against loss by overproduction or from inability to speedily market a perishable crop, and the pickle market receives the benefit of a steady supply.

HOW BRINING PRESERVES VEGETABLES

When vegetables are placed in brine the juices and soluble material contained in them are drawn out by the force known as osmosis.

The fermentable sugar present in all fruits and vegetables, which is one of the soluble substances extracted by osmotic action, serves as food for the lactic-acid bacteria which break it down into lactic acid and certain volatile acids. In some vegetables, like cucumbers and cabbage, where the supply of sugar is ample and other conditions are favorable to the growth of the lactic bacteria, a decided acid formation takes place, constituting a distinct fermentation. The acid brine thus formed acts upon the vegetable tissues, bringing about the changes in color, taste, and texture which mark the pickled state.

As a rule, a solution of salt is used, although some vegetables quickly give up enough moisture to convert dry salt into brine. Salt also hardens or makes firm the vegetables placed in brine and checks the action of organisms which might otherwise destroy the plant tissues.

Cabbage is well preserved in its own brine in the form of sauerkraut. Other vegetables and some fruits may, under certain conditions, be economically preserved by brining. As a rule, however, canning is preferable for these products, because food values and natural flavors are better preserved by that method. Lack of time, a shortage of cans, or an oversupply of raw material may justify the preservation of vegetables other than cucumbers and cabbage by curing in brine.

EQUIPMENT FOR BRINING AND PICKLING

Stone jars are the most convenient and desirable receptacles (fig. 1) for making small quantities of pickles. Stoneware is much more easily kept clean and absorbs objectionable odors and flavors to a smaller extent than wood. Straight-side, open-top jars, which come in practically all sizes, from 1 to 20 gallons, are best for this purpose. Those used for the directions given in this bulletin are 4-gallon jars which hold about 12 pounds (one-fourth bushel) of cucumbers.



FIG. 1.—Some suitable containers for home-brined products

If only very small quantities of pickles are put up, wide-mouth bottles or glass jars will do.

Water-tight kegs or barrels are best for making larger quantities of pickles. Those used for the directions given in this bulletin are barrels holding from 40 to 45 gallons. They must first be washed, or possibly charred, to remove all undesirable odors and flavors. Undesirable flavors may be removed by using solutions of potash or soda lye. A strong solution of lye should remain in the barrel for several days, after which the barrel should be thoroughly soaked and washed with hot water until the lye is removed.

Boards about an inch thick make the best covers. These may be of any kind of wood, except yellow or pitch pine, which would give the pickles an undesirable flavor. They should be from 1 to 2 inches less in diameter than the inside of the jar or barrel, so that they may be easily removed. Dipping the covers in paraffin and then burning them over with a flame fills the pores of the wood, thus making it comparatively easy to keep them clean. Heavy plates of suitable size may be used instead of boards as covers for small containers.

A clean white cloth is often needed to cover the material in the jar or barrel. Two or three thicknesses of cheesecloth or muslin, cut in circular form, and about 6 inches larger in diameter than the inside of the receptacle, makes a suitable covering. Sometimes grape, beet, or cabbage leaves are used for this purpose. Grape leaves are a good covering for dill pickles, and cabbage leaves for sauerkraut.

In addition to the jars, crocks, or kegs in which the pickles are made, 2-quart glass jars are needed for packing the finished product. If corks are used for sealing such containers, they should first be dipped in hot paraffin.

When vegetables which have been fermented in a weak brine are to be kept for any length of time, air must be excluded from them. This may be done by sealing the containers with paraffin, beeswax, or oil. Paraffin, the cheapest and probably the best of these three substances, is easily handled and readily separated from the pickles when they are removed from the containers. To remove any dirt, the paraffin should be heated and strained through several thicknesses of cheesecloth. Thus the paraffin may be used over and over again. The clean paraffin is melted and poured over the surface of the pickles in quantities sufficient to make, when hardened, a solid coating about half an inch thick. Where there are vermin, lids should be placed over the paraffin in jars and other covers should be placed over the paraffin in kegs. If applied before active fermentation has stopped, the seal may be broken by the formation of gas below the layer, making it necessary to remove the paraffin, heat it again, and once more pour it over the surface.

In many cases a safer and better plan for preserving vegetables fermented in a weak brine is to transfer the pickled product to glass jars as soon as fermentation is completed and seal tightly.

Almost anything which furnishes the required pressure will serve as a weight to hold the mass down in a jar or keg. Clean stones (except limestone) and bricks are recommended.

A pair of kitchen scales and suitable vessels for determining liquid measure are, of course, essential.

The salinometer, an instrument for measuring the salt strength of a brine, is very useful, although not absolutely necessary, in brining (fig. 2). By following the directions given here it will be possible to make brines of the required strength without the use of this instrument. Results may be readily checked, however, and any changes in brine strength which occur from time to time may be detected by the use of the salinometer.

The salinometer scale is graduated into 100 degrees, which indicate the range of salt concentration between 0°, the reading for pure water at 60° F., and 100°, which indicates a saturated salt solution

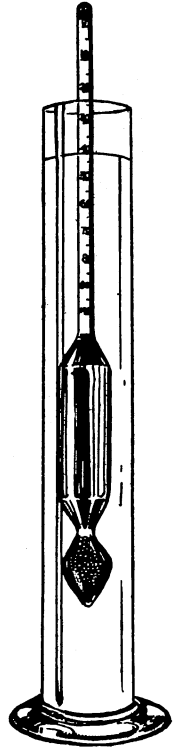


FIG. 2.—Salinometer

(26½ per cent). Table 1 (page 14) shows the relation between salinometer readings and salt percentages.

Salinometers are sold for about \$1 each by firms dealing in chemical apparatus and supplies.

A sugar hydrometer is very useful in all canning and pickling work. Either the Brix or Balling scale may be used. Both read directly in percentages of sugar in a pure sugar solution. A Balling hydrometer, graduated from 0° to 70°, is a convenient instrument for the tests indicated in this bulletin.

SUPPLIES FOR BRINING AND PICKLING

SALT

Fine table salt is not necessary. What is known as common fine salt, or even coarser grades, may be used. Caked or lumpy salt can not be equally distributed. Salt to which anything has been added to prevent caking is not recommended for pickling and brining. Alkaline impurities in the salt are especially objectionable. Any noncaking salt which contains less than 1 per cent of the carbonates or bicarbonates of sodium, calcium, or magnesium may be used for this purpose.

VINEGAR

A good, clear vinegar of 40 to 60 grain strength (4 to 6 per cent acetic acid) is required in making sour, sweet, and mixed pickles, and is sometimes used for dill pickles. Many pickle manufacturers prefer distilled vinegar, as it is colorless and free from sediment. If fruit vinegars are used they should first be filtered to remove all sediment.

SUGAR

Granulated sugar should be used in making sweet pickles. The quantity of sugar required for each gallon of vinegar in making sweet liquors is shown in Table 3 (p. 15).

SPICES

Spices are used to some extent in making nearly all kinds of pickles, but chiefly for sweet, mixed, and dill pickles. Various combinations are used, depending on the kind of pickles to be made and the flavor desired.

Peppers (black and cayenne), cloves, cinnamon, celery seed, caraway, dill herb, mustard (yellow), allspice, cardamom, bay leaves, coriander, turmeric, and mace, are the principal whole spices for this purpose. Ginger and horse-radish root are used sometimes. All of these spices may be purchased in bulk and mixed as desired. Mixed whole spices, specially prepared for pickling purposes, sold in the stores, are, as a rule, satisfactory. Care should be taken to see that they are of proper strength.

Oil spices may be desirable under some circumstances, but their effect is not so lasting as that of the whole spices.

Turmeric has been much used in both the commercial and household preparation of pickles. While some of its qualities entitle it

to be classed among the spices, it does not rank in importance as such with the others named. It is employed largely because of its supposed effect on the color of pickles, which is probably overestimated.

Dill herb is practically always used with cucumbers when they are fermented in a weak brine and often with other vegetables fermented in this way. It gives the pickle a distinct flavor which is very popular. The dill herb, a native of southern Europe, can be grown in nearly all parts of the United States and usually is obtainable in the markets of the larger cities. While the entire stalk of the dill herb is of value for flavoring, the seeds are best suited for imparting the desired flavor. For this reason the crop should be harvested only after the seeds have become fully mature but are not so ripe that they fall off. The herb may be used green, dried, or brined. When green or brined dill is used, twice as much by weight as would be required if the dried herb were used is taken. Dill retains its flavor for a long time when brined. To preserve it in this way it should be packed in a 60° brine, or in an 80° brine if it is to be kept for a long time. Dill brine is as good as the herb for flavoring.

CUCUMBER PICKLES

Because of their shape, firmness, or keeping quality some varieties of cucumbers, notably Chicago Pickling, Boston Pickling, and Snow's Perfection, are better adapted for making pickles than others. Cucumbers of practically all varieties, sizes, and shapes, however, make good pickles,¹ provided they are free from disease and are taken from the vines before they approach the ripening stage.

Cucumbers to be pickled should retain from one-eighth to one-fourth inch of their stems, and they should not be bruised. If dirty they should be washed before brining. They should be placed in brine not later than 24 hours after they have been gathered.

Cucumbers contain approximately 90 per cent of water. As this large water content reduces materially the salt concentration of any brine in which they are fermented, it is necessary to add an excess of salt at the beginning of a fermentation in the proportion of 1 pound for every 10 pounds of cucumbers.

The active stage of cucumber fermentation continues for 10 to 30 days, depending largely on the temperature at which it is conducted. The most favorable temperature is 86° F.

Practically all the sugar withdrawn from the cucumbers is utilized during the stage of active fermentation, at the end of which the brine reaches its highest degree of acidity. During this period the salt concentration should not be materially increased; for, although the lactic bacteria are fairly tolerant of salt, there is a limit to their tolerance. The addition of a large quantity of salt at this time would reduce their acid-forming power just when this is essential to a successful fermentation. Salt, therefore, should be added gradually over a period of weeks.

SALT PICKLES

Salt pickles, or salt stock, are made by curing cucumbers in a brine which should contain not less than 9.5 per cent of salt (approximately 36° on the salinometer scale) at the start. Not only must the

¹ Information on the cultivation of cucumbers, and the diseases and enemies which attack them, may be obtained from the United States Department of Agriculture.

brine be kept at this strength, but salt should be added until it has a concentration of about 15 per cent (60° on the salinometer scale). If well covered with a brine of this strength, the surface of which is kept clean, pickles will keep indefinitely.

Proper curing of cucumbers requires from six weeks to two months, or possibly longer, according to the temperature at which the process is carried out and the size and variety of the cucumbers. Attempts to use short cuts or to make pickles overnight, as is sometimes advised, are based on a mistaken idea of what really constitutes a pickle.

Curing of cucumbers is marked by an increased firmness, a greater degree of translucency, and a change in color from pale green to dark or olive green. These changes are uniform throughout the perfectly cured specimen. So long as any portion of a pickle is whitish or opaque it is not perfectly cured.

After proper processing in water, salt pickles may be eaten as such or they may be converted into sour pickles (p. 7), sweet pickles (p. 8), mixed pickles (p. 10), or pickle relish.

SMALL QUANTITIES

Pack the cucumbers in a 4-gallon jar and cover with 6 quarts of a 10 per cent brine (40° on salinometer scale). At the time of making up the brine, or not later than the following day, add more salt at the rate of 1 pound for every 10 pounds of cucumbers used—in this case 1 pound and 3 ounces. This is necessary to maintain the strength of the brine.

Cover with a round board or plate that will go inside the jar, and on top of this place a weight heavy enough to keep the cucumbers well below the surface of the brine.

At the end of the first week, and at the end of each succeeding week for five weeks, add one-fourth pound of salt. In adding salt always place it on the cover. If it is added directly to the brine, it may sink, as a result of which the salt solution at the bottom will be very strong, while that near the surface may be so weak that the pickles will spoil.

A scum, made up usually of wild yeasts and molds, forms on the surface. As this may prove injurious by destroying the acidity of the brine, remove it by skimming.

LARGE QUANTITIES

Put into a barrel 5 to 6 inches of a 40° brine (Table 1, p. 14) and add 1 quart of good vinegar. In this brine place the cucumbers as they are gathered. Weigh the cucumbers each time before they are added. Put a loose-fitting wooden cover over the cucumbers and weight it down with a stone heavy enough to bring the brine over the cover. After the cover and stone have been replaced add to the brine over the cover 1 pound of salt for every 10 pounds of cucumbers.

Unless the cucumbers are added too rapidly, it will be unnecessary to add more brine, for when a sufficient weight is maintained on the cover the cucumbers make their own brine. If, however, the cucumbers are added rapidly, or if the barrel is filled at once, more brine may be required. In such a case, add enough of the 40° brine to cover the cucumbers.

When the barrel is full, add 3 pounds of salt each week for five weeks (15 pounds to a 45-gallon barrel). In adding the salt, place it on the cover. Added in this way it goes into solution slowly, insuring a brine of uniform strength throughout and a gradually increasing salt concentration. Thus, shriveling of the pickles is prevented to a great extent and the growth and activity of the lactic bacteria are not seriously checked.

Stirring or agitation of the brine may be harmful for the reason that the introduction of air bubbles is conducive to the growth of spoilage bacteria.

From time to time remove the scum which forms on the surface.

Where cucumbers are grown extensively for the production of pickles, curing is done in large tanks at salting stations. While it involves certain details of procedure not required in barrel quantities, this method of curing is essentially the same.

PROCESSING

After being cured in brine, pickles must receive a processing in water to remove the excess of salt. If they are to be used as salt pickles, only a partial processing is required. If, however, they are to be made into sour, sweet, or mixed pickles, the salt should be largely, but not completely, removed. Pickles keep better when the salt is not entirely soaked out.

Under factory conditions, processing is accomplished by placing the pickles in tanks, which are then filled with water and subjected to a current of steam, the pickles being agitated meanwhile. Very few homes, however, have the equipment for such treatment.

The best that can be done in the home is to place the pickles in a suitable vessel, cover them with water, and heat them slowly to about 120° F., at which temperature they should be held for from 10 to 12 hours, being stirred frequently. The water is then poured off, and the process is repeated, if necessary, until the pickles have only a slightly salty taste.

SORTING

After processing, the pickles should be sorted. To secure the most attractive product, pickles should be as nearly as possible of uniform size. At least three sizes are recognized—small (2 to 3 inches long), medium (3 to 4 inches long), and large (4 inches or longer). Only the small sizes are selected for bottling. Fairly small and medium-large cucumbers are well adapted to the making of sweet pickles. Dill pickles are best made from medium-size cucumbers. The larger sizes may be used for sour pickles. Imperfectly formed pickles, the so-called crooks and nubs, can be cut up and added to mixed pickles or other combinations of which cucumbers form a part. The number of pickles of various sizes required to make a gallon is shown in Table 4, page 16.

SOUR PICKLES

After pickles have been processed sufficiently, drain them well and cover them at once with vinegar. A 45 or 50 grain vinegar usually gives all the sourness that is desirable. If, however, very sour pickles are preferred, it would be well to use at first a 40 or 45 grain vinegar, and after a week or 10 days transfer the pickles to a vinegar of the

strength desired. As the first vinegar used will in all cases be greatly reduced in strength by dilution with the brine contained in the pickles, it will be necessary to renew the vinegar after a few weeks. If this is not done and the pickles are held for any length of time they may spoil.

The best containers for sour pickles are stone jars, or, for large quantities, kegs or barrels. Covered with a vinegar of the proper strength, pickles should keep indefinitely.

SWEET PICKLES

Cover the cured and processed cucumbers with a sweet liquor made by dissolving sugar in vinegar, usually with the addition of spices. Depending upon the degree of sweetness desired, the quantity of sugar may vary from 4 to 10 pounds to the gallon of vinegar, 6 pounds to the gallon usually giving satisfactory results. The chief difficulty in making sweet pickles is their tendency to become shriveled and tough, which increases with the sugar concentration of the liquor. This danger can usually be avoided by covering the pickles first with a plain 45 to 50 grain vinegar. After one week discard this vinegar, which in all probability has become greatly reduced in strength, and cover with a liquor made by adding 4 pounds of sugar to the gallon of vinegar. It is very important that the acidity of the liquor used on pickles be kept as high as possible. A decrease in acidity much below a 30-grain strength may permit the growth of yeasts, with resulting fermentation and spoilage.

If a liquor containing more than 4 pounds of sugar to the gallon is desired, it would be best not to exceed that quantity at first, but gradually add sugar until the desired concentration is obtained. A sugar hydrometer readily indicates the sugar concentration (p. 4). A reading of 42° (Brix or Balling) would indicate a concentration of approximately 6 pounds of sugar to the gallon of vinegar. (Table 3, p. 15.)

Spices are practically always added in making sweet pickles. The effect of too much spice, especially the stronger kinds, like peppers and cloves, however, is injurious. One ounce of whole mixed spices to 4 gallons of pickles is enough. As spices may cause cloudiness of the vinegar, they should be removed after the desired flavor has been obtained. Heating is an aid to a better utilization of the spice. Add the required quantity of spice, in a cheesecloth bag, to the vinegar and hold at the boiling point for not longer than half an hour. Heating too long causes the vinegar to darken. If considered desirable, add sugar at this time, and pour at once over the pickles.

If the pickles are to be packed in bottles or jars, after such preliminary treatment as may be required, transfer them to these containers and cover them with a liquor made as desired.

DILL PICKLES

The fermentation of pickles is much more rapid in a brine containing 5 per cent of salt than in one containing 10 per cent. The addition of flavoring substances does not affect the rate of fermentation. Pickles fermented in the weaker brine, however, are usually flavored with spices, chiefly dill herb, which gives them their common name. Dill pickles can be made in about half the time required for the preparation of ordinary brined pickles. This shortening

of the period of preparation, however, is gained at the expense of the keeping quality of the product. For this reason it is necessary to resort to measures which will prevent spoilage.

SMALL QUANTITIES

Place in the bottom of the jar a layer of dill and one-half ounce of mixed spice. Then fill the jar, to within 2 or 3 inches of the top, with washed cucumbers of as nearly the same size as practicable. Add another half ounce of spice and layer of dill. It is a good plan to place over the top a layer of grape leaves. In fact, it would be well to place these at both the bottom and top. They make a very suitable covering and have a greenening effect on the pickles.

Pour over the pickles a brine made as follows: Salt, 1 pound; vinegar, 1 pint; water, 2 gallons. Never use a hot brine at the beginning of a fermentation. The chances are that it would kill the organisms present, thus preventing fermentation.

Cover with a board cover or plate with sufficient weight on top to hold the cucumbers well below the brine.

If the cucumbers are packed at a temperature around 86° F., an active fermentation will at once set in. This should be completed in 10 days to 2 weeks, if a temperature of about 86° F. is maintained. The scum which soon forms on the surface and which consists usually of wild yeasts, but often contains molds and bacteria, should be skimmed off.

After active fermentation has stopped, it is necessary to protect the pickles against spoilage. This may be done in one of two ways:

(1) Cover with a layer of paraffin. This should be poured while hot over the surface of the brine or as much of it as is exposed around the edges of the board cover. When cooled this forms a solid coating which effectually seals the pickles.

(2) Seal the pickles in glass jars or cans. As soon as they are sufficiently cured, which may be determined by their agreeable flavor and dark-green color, transfer them to glass jars, and fill either with their own brine or with a fresh brine made as directed. Add a small quantity of dill and spice. Bring the brine to a boil, and, after cooling to about 160° F., pour it over the pickles, filling the jars full. Seal the jars tight and store in a cool place.

The plan of preserving dill pickles by sealing in jars has the merit of permitting the use of a small quantity without the necessity of opening and resealing a large bulk, as is the case when pickles are packed in large containers and sealed with paraffin.

LARGE QUANTITIES

Fill a barrel with cucumbers. Add 6 to 8 pounds of green or brined dill, or half that quantity of dry dill, and 1 quart of mixed spices. If brined dill is used, it is well to add about 2 quarts of the dill brine. The dill and spices should be evenly distributed at the bottom, middle, and top of the barrel. Also add 1 gallon of good vinegar.²

² This addition of vinegar is not essential, and many prefer not to use it. In the proportion indicated, however, it is favorable to the growth of the lactic bacteria and helps to prevent the growth of spoilage organisms. Its use, therefore, is to be regarded with favor. Some prefer to omit the mixed spices for the reason that they interfere with the distinctive flavor of the dill herb.

Head up tight and, through a hole bored in the head, fill the barrel with a brine made in the proportion of one-half pound of salt to a gallon of water. Add brine until it flows over the head and is level with the top of the chime. Maintain this level by adding brine from time to time. Remove the scum which soon forms on the surface.

During the period of active fermentation, keep the barrel in a warm place and leave the hole in the head open to allow gas to escape. When active fermentation is over, as indicated by the cessation of bubbling and frothing on the surface, the barrel may be plugged tight and placed in storage, preferably in a cool place. Leakage and other conditions may cause the brine in a barrel of pickles to recede at any time. The barrels should be inspected occasionally, and more brine added if necessary. Pickles put up in this way should be ready for use within about six weeks.

When pickles are to be held in storage a long time, a 28° brine, made by adding 10 ounces of salt to a gallon of water, should be used. Pickles packed in a brine of this strength will keep a year, if the barrels are kept filled and in a cool place. The important factor in preserving pickles put up in a weak brine, such as is ordinarily used for dill pickles, is the exclusion of air. When put up in tight barrels this is accomplished by keeping the barrels entirely filled with brine.

MIXED PICKLES

Onions, cauliflower, green peppers, tomatoes, and beans, as well as cucumbers, are used for making mixed pickles. All vegetables should first be cured in brine.

For making mixed pickles, very small vegetables are much to be preferred. If larger ones must be used, first cut them into pieces of a desirable and uniform shape and size. Place in the bottom of each wide-mouth bottle or jar a little mixed spice. In filling the bottle arrange the various kinds of pickles in as neat and orderly a manner as possible. The appearance of the finished product depends largely upon the manner in which they are packed in the bottle. Do not completely fill the bottles.

If sour pickles are desired, fill the bottles completely with a 45-grain vinegar. If sweet ones are wanted, fill with a liquor made by dissolving 4 to 6 pounds of sugar in a gallon of vinegar.

Seal tight, and label properly.

SAUERKRAUT

For making sauerkraut in the home, 4 or 6 gallon stone jars are considered the best containers, unless large quantities are desired, in which case kegs or barrels may be used.

Select only mature, sound heads of cabbage. After removing all decayed or dirty leaves, quarter the heads and slice off the core portion. For shredding, one of the hand-shredding machines which can be obtained on the market is much the best, although an ordinary slaw cutter or a large knife will do.

In making sauerkraut the fermentation is carried out in a brine made from the juice of the cabbage which is drawn out by the salt.

One pound of salt for every 40 pounds of cabbage makes the proper strength of brine to produce the best results. The salt may be distributed as the cabbage is packed in the jar or it may be mixed with the shredded cabbage before being packed. The distribution of 2 ounces of salt with every 5 pounds of cabbage probably is the best way to get an even distribution.

Pack the cabbage firmly, but not too tightly, in the jar or keg. When full, cover with a clean cloth and a board or plate. On the cover place a weight heavy enough to cause the brine to come up to the cover.

If the jar is kept at a temperature of about 86° F., fermentation will start promptly. A scum soon forms on the surface of the brine. As this scum tends to destroy the acidity and may affect the cabbage, it should be skimmed off from time to time.

If the jar is kept at 86° F., the fermentation should be completed within 10 days.

A well-fermented sauerkraut should show a normal acidity of approximately +20, or a lactic acid percentage of 1.8 (p. 16).

After fermentation is complete, set the sauerkraut in a cool place. If the cabbage is fermented late in the fall, or if it can be stored in a very cool place, it may not be necessary to do more than keep the surface skimmed and protected from insects, etc.; otherwise it will be necessary to resort to one of the following measures to prevent spoilage:

- (1) Pour a layer of hot paraffin over the surface, or as much of it as is exposed around the cover. Properly applied to a clean surface, this effectually seals the jar and protects the contents from contamination.

- (2) After the fermentation is complete, pack the sauerkraut in glass jars, adding enough of the "kraut" brine, or a weak brine made by adding an ounce of salt to a quart of water, to completely fill the jars.

The second method is much to be preferred to the first. If it is heated before sealing in a water bath until the temperature of the center of the jar is about 160° F. and then stored in a cool place, sauerkraut packed in this way will keep in good condition for a year or longer.

In the commercial canning of sauerkraut, where conditions and length of storage can not be controlled, heat must always be used.

FERMENTATION AND SALTING OF VEGETABLES OTHER THAN CUCUMBERS AND CABBAGE

There are three methods of preserving vegetables by the use of salt:

FERMENTATION IN AN ADDED BRINE

Experiments have shown that string beans, green tomatoes, beets, chayotes, mango melons, burr gherkins, and corn (on cob) may be well preserved in a 10 per cent brine (40° on the salinometer scale) for several months. Cauliflower and peppers are best preserved in a 60° brine and onions in an 80° brine. The brine must be main-

tained at its original strength by the gradual addition of salt (p. 6), and the surface of the brine must be kept free from scum. Some of the vegetables listed, notably string beans and green tomatoes, are well adapted to fermentation in a weak brine (5 per cent salt), in which case dill and other spices may be added. The general directions given for dill pickles (p. 8) should be followed.

FERMENTATION IN BRINE PRODUCED BY DRY SALTING

This method, of course, can be used only for vegetables which contain enough water to make their own brine. String beans, if young and tender, may be preserved in this way. Remove tips and strings, and, if the pods are large, break them in two. Older beans, and doubtless other vegetables, could be preserved by this method if first shredded in the same manner as cabbage (p. 10). Use salt equal to 3 per cent of the weight of the vegetables (1 ounce salt to about 2 pounds vegetables).

SALTING WITHOUT FERMENTATION

Enough salt to prevent all bacterial action must be added. Wash and weigh the vegetables. Mix with them thoroughly one-fourth their weight of salt. If after the addition of pressure there is not enough brine to cover the product, add brine made by dissolving 1 pound of salt in 2 quarts of water. As soon as bubbling ceases, protect the surface by covering with paraffin. This method is especially well adapted to vegetables in which the sugar content is too low to produce a successful fermentation, such as chard, spinach, and dandelions. Corn can also be well preserved in this way. Husk it and remove the silk. Cook it in boiling water for 10 minutes, to set the milk. Then cut the corn from the cob with a sharp knife, weigh it, and pack it in layers, with one-fourth its weight of fine salt.

The methods of preservation outlined are not limited to vegetables. Solid fruits, like clingstone peaches and Kieffer pears, can be preserved in an 80° brine for as long as six months. After the salt has been soaked out, they may be worked up into desirable products by the use of spices, vinegar, sugar, etc. Soft fruits, like Elberta peaches and Bartlett pears, are best preserved in weak vinegar (2 per cent acetic acid).^a

CAUSES OF FAILURE

SOFT OR SLIPPERY PICKLES

A soft or slippery condition, one of the most common forms of spoilage in making pickles, is the result of bacterial action. It always occurs when pickles are exposed above the brine and very often when the brine is too weak to prevent the growth of spoilage organisms. To prevent it keep the pickles well below the brine and the brine at the proper strength. To keep pickles for more than a

^a Report of an investigation in the Bureau of Chemistry on the utilization of brined products, by Rhea C. Scott, 1919.

very few weeks a brine should contain 15 per cent of salt. Once pickles have become soft or slippery as a result of bacterial action no treatment will restore them to a normal condition.

HOLLOW PICKLES

Hollow pickles may occur during the process of curing. This condition, however, does not mean a total loss, for hollow pickles may be utilized in making mixed pickles or certain forms of relish. While there are good reasons to believe that hollow pickles are the result of a faulty development or nutrition of the cucumber, there is also a strong probability that incorrect methods may contribute to their formation. One of these is allowing too long a time to intervene between gathering and brining. This period should not exceed 24 hours.

Hollow pickles frequently become floaters. Sound cucumbers properly cured do not float, but any condition which operates to lower their relative weight, such as gaseous distention, may cause them to rise to the surface.

EFFECT OF HARD WATER

So-called hard waters should not be used in making a brine. The presence of large quantities of calcium and some other salts found in many natural waters may prevent the proper acid formation, thus interfering with normal curing. The addition of a small quantity of vinegar serves to overcome alkalinity when hard water must be used. If present in any appreciable quantity, iron is objectionable, causing a blackening of the pickles under some conditions.

SHRIVELING

Shriveling of pickles often occurs when they have been placed at once in very strong salt or sugar solutions, or even in very strong vinegars. For this reason avoid such solutions so far as possible. When a strong solution is desirable the pickles should first be given a preliminary treatment in a weaker solution. This difficulty is most often encountered in making sweet pickles. The presence of sugar in high concentrations is certain to cause shriveling unless precautions are taken (p. 8).

EFFECT OF TOO MUCH SALT ON SAUERKRAUT

Perhaps the most common cause of failure in making sauerkraut is the use of too much salt. The proper quantity is $2\frac{1}{2}$ per cent by weight of the cabbage packed. When cabbage is to be fermented in very warm weather it may be well to use a little more salt, but not to exceed 3 per cent. In applying the salt see that it is evenly distributed. The red streaks which are sometimes seen in sauerkraut are believed to be due to uneven distribution of salt.

EFFECT OF SCUM

Spoilage of the top layers of vegetables fermented in brine is sure to occur unless the scum which forms on the surface is frequently removed. This scum is made up of wild yeasts, molds, and bacteria,

which, if allowed to remain, attack and break down the vegetables beneath. They may also weaken the acidity of the brine, in which way they may cause spoilage. The fact that the top layers have spoiled does not necessarily mean, however, that all in the container are spoiled. The molds and other organisms which cause the spoilage do not quickly get down to the lower layers. The part found in good condition often may be saved by carefully removing the spoiled part from the top, adding a little fresh brine, and pouring hot paraffin over the surface.

EFFECT OF TEMPERATURE

Temperature has an important bearing on the success of a lactic fermentation. The bacteria which are essential in the fermentation of vegetable foods are most active at a temperature of approximately 86° F., and as the temperature falls below this point their activity correspondingly diminishes. It is essential, therefore, that the foods be kept as close as possible to 86° F. at the start and during the active stages of a fermentation. This is especially important in the production of sauerkraut, which is often made in the late fall or winter. The fermentation may be greatly retarded or even stopped by too low a temperature.

After the active stages of a fermentation have passed, store the food in a cool place. Low temperatures are always an aid in the preservation of food products.

COLORING AND HARDENING AGENTS

To make what is thought to be a better looking product, it is the practice in some households to "green" pickles by heating them with vinegar in a copper vessel. Experiments have shown that in this treatment copper acetate is formed, and that the pickles take up very appreciable quantities of it. *Copper acetate is poisonous.*

By a ruling of the Secretary of Agriculture, made July 12, 1912, foods greened with copper salts, all of which are poisonous, will be regarded as adulterated.

Alum is often used for the purpose presumably of making pickles firm. The use of alum in connection with food products is of doubtful expediency, to say the least. If the right methods are followed in pickling, the salt and acids in the brine will give the desired firmness. The use of alum, or any other hardening agent, is unnecessary.

TABLES AND TESTS

TABLE 1.—Salt percentages, corresponding salinometer readings, and quantity of salt required to make 6 quarts of brine

Salt in solution	Salinometer reading	Salt in 6 quarts of finished brine	Salt in solution	Salinometer reading	Salt in 6 quarts of finished brine
<i>Per cent</i>	<i>Degrees</i>	<i>Ounces</i>	<i>Per cent</i>	<i>Degrees</i>	<i>Ounces</i>
1.06	4	2	8.48	32	18
2.12	8	4½	9.54	36	20
3.18	12	6½	10.6	40	22½
4.24	16	8½	15.9	60	35
5.3	20	11	21.2	80	48
6.36	24	13	26.5	100	64
7.42	28	14½			

The figures given in the first two columns of Table 1 are correct. Those in the last column are correct within the possibilities of ordinary household methods. To make up a brine from this table, the required quantity of salt is dissolved in a smaller volume of water and water is added to make up as nearly as possible to the required 6 quarts.

One pound of salt dissolved in 9 pints of water makes a solution with a salinometer reading of 40°, or approximately a 10 per cent brine. In a brine of this strength, fermentation proceeds somewhat slowly. Pickles kept in a brine maintained at this strength will not spoil. One-half pound of salt dissolved in 9 pints of water makes approximately a 5 per cent brine, with a salinometer reading of 20°. A brine of this strength permits a rapid fermentation, but vegetables kept in such a brine will spoil within a few weeks if air is not excluded.

A brine in which a fresh egg just floats is approximately a 10 per cent solution.

Fermentation takes place fairly well in brines of 40° strength, and will, to some extent at least, up to 60°. At 80° all fermentation stops.

The volume of brine necessary to cover vegetables is about half the volume of the material to be fermented. For example, if a 5-gallon keg is to be packed, 2½ gallons of brine is required.

TABLE 2.—Freezing point of brine at different salt concentrations

Salt	Salinometer reading	Freezing temperature
<i>Per cent</i>	<i>Degrees</i>	<i>° F.</i>
5	20	25.2
10	40	18.7
15	60	12.2
20	80	6.1
25	100	0.5

TABLE 3.—Density of sugar sirup

Density	Quantity of sugar for each gallon of water ¹	Density	Quantity of sugar for each gallon of water ¹
<i>Degrees Brix or Balling</i>	<i>Lbs. Ozs.</i>	<i>Degrees Brix or Balling</i>	<i>Lbs. Ozs.</i>
5	7	35	4 7.75
10	14.8	40	5 8.75
15	1 7.5	45	6 13
20	1 14.75	50	8 5.25
25	2 12.5	55	10 4
30	3 9	60	12 8

¹ When vinegar is used, the equivalent sugar hydrometer reading would be about 2 degrees higher than that indicated in the table.

TABLE 4.—*Number of cucumbers of various sizes required to make a gallon of pickles*

Size	Variety	Number to a gallon
1 to 2 inches long.....	Gherkins ¹	250 to 650
2 to 3 inches long.....	Small pickles.....	130 to 250
3 to 4 inches long.....	Medium pickles.....	40 to 130
4 inches and longer.....	Large pickles.....	12 to 40

¹ Small pickles are usually designated as gherkins. Those of very small size are sometimes called midgets.

The maximum acidity formed by a lactic fermentation of vegetables in brine varies from 0.25 to 2 per cent. The maximum is reached at or soon after the close of the active stage of fermentation. After this the acidity usually decreases slowly. The stage of active fermentation continues for from one to three weeks, depending upon the temperature, strength of brine, etc. During this period gas is formed and froth appears on the surface, owing to the rising of gas bubbles. At the close of this period the brine becomes "still."

The quantity of acid formed depends primarily upon the sugar content of the vegetables fermented, but it may be influenced by other factors.

Dipping a piece of blue litmus paper (obtainable at drug stores) in the brine will show whether the brine is acid. If the paper turns pinkish or red, the brine is acid, but the litmus paper does not give a definite indication of the degree of acidity.

For those who want to know accurately what the degree of acidity is the following method is outlined:

With a pipette transfer exactly 10 cubic centimeters of the brine to a small evaporating dish. To this add 40 cubic centimeters of distilled water and 4 or 5 drops of a 0.5 per cent solution of phenolphthalein in 50 per cent alcohol. Then run in slowly a one-tenth normal sodium hydroxide solution. This is best done by using a 25 cubic centimeter burette, graduated in tenths. As the sodium hydroxide is being added stir constantly, and note carefully when the entire liquid shows a faint pink tint. This indicates that the neutral point has been reached. Read off carefully the exact quantity of sodium hydroxide required to neutralize the mixture in the dish. This number multiplied by 0.09 gives the number of grams of acid per 100 cubic centimeters, calculated as lactic, present in the brine.

This method can be used to determine the acid strength of vinegars. Multiply by 0.06 to ascertain the number of grams of acetic acid per 100 cubic centimeters present in the vinegar.

The apparatus and chemicals needed for this test can be obtained from any firm dealing in chemical apparatus and supplies.